Despite the fascination that it holds for birdwatchers, the Goshawk *Accipiter gentilis* in the wild remains a rarely sighted and understudied species in Britain. Following persecution in the nineteenth century, it was lost as a regular breeding species for nearly a hundred years, until a small population re-established in the wild from escaped (or released) birds of falconers (Kenward 1974). There is now a restricted population in Britain, which is increasing despite persecution (Spencer et al. 1986).

The notes that follow are from continuous observations of a small breeding population in lowland Britain. One of the original female colonists in our study area bore a leather anklet and, even as recently as 1984, a male with a tail bell appeared in our population, indicating that escaped individuals still initiate and may swell a wild breeding population.

The study area comprises 270 km$^2$, of which some 52% is woodland: mixed broadleaves, oak high forest and coniferous plantations (the latter dating from the early 1900s). The remainder is mixed farmland or urban. The majority of the woodland is managed, with a continuous cycle of felling and replanting. The altitudinal range lies between 50 m and 200 m above sea level, with occasional areas rising to 300 m.

We consulted the Species Protection Department of the RSPB before accepting this paper for publication. The expert view was that 'The paper is very interesting and will provide a worthwhile contribution to the conservation of the species. Much of the information is relevant when considering species' management throughout the bird's range in Britain.' EDS
Data have been collected over the period 1979-86 from 50 known nesting attempts. The area now contains 15-20 breeding pairs. Throughout this paper, the term 'pair' is used to denote the two birds occupying a site, which may not be the same two individuals in successive years.

**Methods**

The Goshawk is a Schedule 1 species and a licence is required even to approach a breeding site. During February to March, early-morning visits were made to areas of woodland where the species was known to be present or was likely to occur. Goshawks are very vocal at this time of year, and this, together with observations of aerial display over suitable sites, enabled breeding areas to be located. Searching at this time was kept to a minimum, in order to avoid disturbance. In early April, the nest trees were climbed and eggs checked. During a return visit in May/June, the chicks were ringed and sexed in the nest. Once the young had flown, measurements were taken of the tree, the woodland type and its density. Aspects of the breeding biology of Goshawks are intended for a future paper.

**Population build-up**

Since the first pair was discovered breeding in 1979, the population had risen to a minimum of 15 pairs by 1986 (fig. 1). Part of the study area (fig. 2) has been intensively searched since before 1979, and we are confident that 1979 was the year in which breeding commenced. The population in that area rose from one pair in 1982 to four in 1984, where it has remained. This pattern of growth is consistent with the usual logistic growth curve. The remainder of the study area has not been so intensively searched and there is the possibility of some pairs remaining undiscovered. The growth pattern is consistent with the exponential rate of increase associated with the initial stages of logistic growth, as shown by logarithmic regression ($R^2 = 0.935$), the increase per year being about 4%. It is not possible at this time to predict the saturation level. Given an undisturbed five-year period, there can be a build-up from a few individuals to a healthy population, possibly then capable of withstanding a moderate degree of persecution.

![Fig. 1. Numbers of known pairs of Goshawks Accipiter gentilis in the study area. Stippled area shows numbers of pairs in block of woodland represented in fig. 2](image-url)
Density of pairs
In our study area, two blocks of mixed woodland (both well defined by a fringe of surrounding farmland and hamlets) held most of the Goshawks, which are rarely seen outside the woodland confines. What little is known about breeding territories of this raptor has been summarised in Cramp & Simmons (1980): 'Nesting territories of adjacent pairs rarely closer than 3 km . . . Densities in areas of mixed woodland and farmland in 4 localities, west and central Europe, c. 3-5 pairs per 100 km$^2$.'

Our study area is probably comparable with this mixed habitat and, despite the difficulties of trying to calculate territory size for relatively localised areas, the apparent breeding densities we recorded are worthy of note. The greatest density was encountered in the 20-km$^2$ block of mixed woodland where establishment originated (fig. 2). There were four breeding pairs during 1983-86, suggesting an average territory size of only 600 ha. The mean distance between nest groups was 1,500 m, the closest were two nests only 1 km apart (in 1985 and 1986), and the two farthest apart were separated by 2 km. This woodland block comprises an unspoiled river valley with numerous prey available, thanks to a mixture of broadleaved and coniferous plantations of a variety of ages. In an adjacent forest block of 69 km$^2$, five pairs were located (although up to nine were suspected), suggesting a maximum territory size of 1,400 ha; the mean distance between nest groups was 2,400 m (range 1,500-3,700 m).

40. Prime habitat for Goshawks Accipiter gentilis, where nests can be as close as 1 km; January 1988
‘In boreal regions, numbers fluctuate markedly from year to year depending on food supply’ (Cramp & Simmons 1980). Our study area, with densities considerably greater than other quoted figures, would appear to be prime habitat for the species.

**Nest fidelity**

Goshawks vary in their allegiance to a nest. A change of one member of a pair, lack of success, or disturbance during the breeding season are all likely to cause them to move. Examining the pattern of behaviour in 33 successive nesting attempts showed that only six (18%) involved reuse of the same nest, including two cases of the same nest being used over three seasons (one in Douglas fir *Pseudotsuga menziesii* and one in larch *Larix*). The study area is not particularly prone to disturbance, and in only eight cases could we attribute the move to possible disturbance. Although we cannot rule out the possibility that our visits to the nests may have caused some moves, it would appear that 58% (19 out of 33) involved new nests being built for no apparent reason.

Some of the more extreme examples of nest fidelity were as follows:

Pair A, watched over eight seasons, moved seven times, using six different nests. All moves but the initial one were within an area of 100 m diameter. During the period, suitable areas for nesting had been felled, so that what was initially 9 ha of mature mixed woodland became a 1.25-ha block of oak *Quercus*.

Pair B, in a Douglas fir stand, used the same nest for three years, and moved less than 100 m for the fourth season.

Pair C, also in Douglas fir, remained in the same stand for four seasons, using three different nests all within 50 m of each other. During the period, the stand was reduced from 20 ha to approximately 5 ha.

Pair D by contrast moved every season for three years, each time a distance of at least 600 m.

Why there may be a tendency to move from one year to the next is unclear. It may be to prevent the build-up of parasites or disease in a nest. One effect of moving, a feature of *Accipiter* species, is that there tend to be several old nests in a favoured block of woodland. Although the general rule is to use a new nest (or one from an earlier year) rather than the one from the preceding year, a number of old nests can be renovated (see below), the final choice presumably being made at the last moment. There may be some advantage in this, since disturbance, or sudden natural catastrophe, could result in a move at short notice to another nest requiring only a day or two’s work prior to laying.

**Nest trees and plantation type**

Of 50 nests, 18 were in larch, 16 in Douglas fir, seven in oak, five in pine
Pinus, three in beech *Fagus sylvatica* and one in Sitka spruce *Picea sitchensis*: a total of 40 in conifers and ten in broadleaves. These figures, however, are of little value without some idea of the relative abundance of each tree in the forest. Thirty-seven nests were within that part of the forest where the species composition of trees is known. When corrected for the proportions of each stand type available, the relative frequencies of nest trees were as follows: pine, 33%; larch, 30%; oak, 19%; Douglas fir, 18%.

This indicates a marked preference for larch and pine trees for nesting. It is even more marked when we consider that seven of the nests were placed in large individual larch trees within oak high forest, the larches being preferred to the more abundant oaks. It may be no coincidence that this combination is chosen, as mature oak plantations provide many of the preferred food items.

Although pine is not abundant in our study area, there seems to be a preference for nesting in it which is not apparent from the limited number of nests found in pine. In four of the five instances, however, the clumps of pine stood out among otherwise smaller stands. The area provided sufficient prey to support a pair, which chose the largest trees for nesting. Where mature stands of the other tree species were available, these were, however, used in preference to pine. Over three successive seasons, only five pairs have remained faithful to a particular tree species (two to Douglas fir, two to larch and one to oak), and at least 39% (13 out of 33) of the moves were from one tree species to another. The most extreme involved pair A, which used larch once, Douglas fir three times and oak four times; different females are believed to have been involved in the first five years and the final three years, and, although the latter female remained in oak, the former moved from larch to Douglas fir, to another Douglas fir, to oak and back to Douglas fir.

**Nest composition and size**

Building was underway by at least February, particularly on fine days, fresh material and down being regularly seen on nests from mid March onwards. Often alternative nests, if available, had varying amounts of material added prior to egg-laying, and occasionally small amounts of greenery could be found lining nests not subsequently used. In one case, three old nests were renovated, but the owners also built a completely new nest in which to lay. Two new nests were built by another pair in one year, one being used successfully, with the second nest being used in the following season. On two occasions, nest-refurbishing was observed in September/October, in both cases after failure in the previous year. It is possible that a sedentary bird such as the Goshawk could add material to nests throughout the non-breeding period.

In our study area, larch is undoubtedly the favoured nest-building material, with 69% of nests (20 out of 29) being composed entirely of larch; a further nest comprised mainly larch. All 12 nests in larch trees were built of this same material. In addition, six nests in oak, one in beech and one in Scots pine *P. sylvestris* were constructed entirely of larch, and one nest in a beech was made of larch and beech. Larch is easy to break
Goshawks build large, bulky nests. As these are normally positioned against the trunk of a conifer, they are kidney-shaped. Fourteen nests, involving different pairs, were measured in a single year. The mean size of eight new nests was $117.8 \times 87.6 \times 39.4$ cm deep; that of six refurbished nests was $121.1 \times 89.3 \times 62.2$ cm deep. Although the smallest ($96.5 \times 63.5$ cm) was a new nest and the largest ($152.4 \times 114.3$ cm) a refurbished one, there was no significant difference (t-test) between new and refurbished except in their depth. Old nests became appreciably deeper only if the old portion had partially toppled out prior to the new structure being built upon it. If the old nest remained intact, relatively little further material (mean 16.5 cm for four nests) was added. Nests never attain the depth proportions of those of other species, such as Golden Eagle *Aquila chrysaetos*, Buzzard *Buteo buteo* or Raven *Corvus corax*, which re-use nests, and they always appear large, flat structures. To construct the nest (even when laying the foundations), Goshawks use predominantly small-diameter sticks, which are easily compressed with time. Of the measured nests, eight were in larch, four in Douglas fir and one each in pine and oak. Although the last two were smaller, the size differences were not significant (t-test). The mean cup size of all nests was $30.8 \times 13.2$ cm deep ($n = 14$; range 25.4-38.1 cm diameter, 10.2-17.8 cm depth).
Linings proved to be more varied than construction materials. In a sample of 22 nests, ten different lining materials were recorded. Ivy *Hedera helix*, found in eight nests, was the most frequent component, though it was never present in large amounts (usually only the occasional leaf or spray). Douglas fir was the more usual general lining, with 32% (seven) of the nests having the cup formed of its soft foliage. Western hemlock *Tsuga heterophylla* was found lining one nest, the only instance where the lining could not have come from the immediate area of the nest. Bark chips and/or strips comprised part of the lining of five nests, the strips often having been nibbled from larch twigs in the nest rim, presumably by the female while incubating. Other lining components comprised larch (four nests), pine (four), dried oak or beech leaves (three), yew *Taxus baccata* (three), spruce (two) and fir *Abies* (one). Fresh pieces of greenery are added during incubation, and copious amounts are brought in during the chick stage to assist in nest hygiene.

**Plantation age and tree size**

All of the plantations chosen by the Goshawks are very old, almost all being at the end of their commercial rotation. Indeed, the broadleaved crops are overmature in forestry terms, which means that many of the sites used in the study area are continually at risk from felling operations. This situation also indicates a clear preference by Goshawks for mature woodland with very large trees in which to breed. Mean ages of nest trees
Table 1. Mean age and diameter at breast height of nest trees used by Goshawks Accipiter gentilis

<table>
<thead>
<tr>
<th>Tree species</th>
<th>Mean age (years)</th>
<th>Sample</th>
<th>Mean diameter at breast height (cm)</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitka spruce Picea sitchensis</td>
<td>41.0</td>
<td>1</td>
<td>38</td>
<td>1</td>
</tr>
<tr>
<td>Douglas fir Pseudotsuga menziesii</td>
<td>57.5</td>
<td>15</td>
<td>54</td>
<td>8</td>
</tr>
<tr>
<td>Pine Pinus</td>
<td>60.8</td>
<td>5</td>
<td>38</td>
<td>3</td>
</tr>
<tr>
<td>Larch Larix</td>
<td>61.4</td>
<td>16</td>
<td>49</td>
<td>14</td>
</tr>
<tr>
<td>Oak Quercus</td>
<td>148.9</td>
<td>7</td>
<td>62</td>
<td>6</td>
</tr>
<tr>
<td>Beech Fagus sylvatica</td>
<td>174.5</td>
<td>2</td>
<td>75</td>
<td>2</td>
</tr>
</tbody>
</table>

are shown in table 1. Of 37 conifers, the mean age was 59.2 years, with a range of 33 (Douglas fir) to 86 years (larch); of 26 conifers measured, the mean diameter at breast height was 48.7 cm. Of nine broadleaves, the mean age was 154.6 years, ranging from 79 (oak) to 184 (beech); of eight measured, the mean diameter was 65.2 cm.

Comparison of the size of the nest tree with those around it indicates that, with few exceptions, the nest tree is larger than its neighbours (fig. 3). As girth is a direct function of canopy size, we can predict that the selection of the largest trees for nesting ensures (i) larger, sturdier branches than on neighbouring trees, thus providing a secure base for the nest, and (ii) better access to the nest tree, since large trees have more ‘elbow room’ than others in the plantation. The average breast-height diameter of the 34 nest trees measured was 52.6 cm, appreciably larger than that of the five nearest neighbouring trees (45.6 cm; n = 166).

Fig. 3. Comparison of mean diameter at breast height (D.B.H.) of nest trees of Goshawks Accipiter gentilis with mean diameter of the five neighbouring trees. SS = Sitka spruce Picea sitchensis, DF = Douglas fir Pseudotsuga menziesii, La = larch Larix, Pi = pine Pinus, Oak = Quercus, Be = beech Fagus sylvatica. Stippled columns represent nest trees, open columns neighbouring trees

**Tree spacing and density**

In our study area, Goshawks nest in the oldest plantations where the trees are well spaced, which is an important factor for a bird whose wingspan
Table 2. Mean distance between trees and density of trees at nest sites of Goshawks

<table>
<thead>
<tr>
<th>Tree species</th>
<th>Mean distance nest tree to nearest tree</th>
<th>Density (stems/ha)</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitka spruce <em>Picea sitchensis</em></td>
<td>5.2 m</td>
<td>256</td>
<td>1</td>
</tr>
<tr>
<td>Douglas fir <em>Pseudotsuga menziesii</em></td>
<td>6.7 m</td>
<td>254</td>
<td>8</td>
</tr>
<tr>
<td>Pine <em>Pinus</em></td>
<td>5.8 m</td>
<td>339</td>
<td>3</td>
</tr>
<tr>
<td>Larch <em>Larix</em> (pure stands)</td>
<td>6.3 m</td>
<td>272</td>
<td>7</td>
</tr>
<tr>
<td>Larch <em>Larix</em> (in oak)</td>
<td>7.7 m</td>
<td>161</td>
<td>7</td>
</tr>
<tr>
<td>Oak <em>Quercus</em></td>
<td>9.9 m</td>
<td>173</td>
<td>6</td>
</tr>
<tr>
<td>Beech <em>Fagus sylvatica</em></td>
<td>9.7 m</td>
<td>104</td>
<td>2</td>
</tr>
</tbody>
</table>

can be up to 165 cm (Cramp & Simmons 1980). Spacing and density of trees at nest sites are presented in table 2. For all sites and tree species combined, the mean distance between nest tree and its immediate neighbours was 7.8 m, with a range of 4.4 m (pine) to 13 m (oak). Broadleaved crops are more open: the trees are naturally more spreading and they have lower stocking rates than conifers. Broadleaved woods generally have approximately half as many stems per hectare as do coniferous woods (table 2).

The Sparrowhawk *Accipiter nisus*, with a wingspan of less than 70 cm, can exploit more densely stocked woods than can Goshawks. It will use the middle years of a plantation’s lifespan, with Goshawks utilising the later stages (Newton 1986), but in our study area the openness of the woods is at the upper range of Newton’s quoted densities.

Nest height and tree height

Goshawk nests are typically three-quarters of the way up the tree (table 3). In a conifer, this zone is where the largest of the living branches are found; below this, dead and brittle branches would prove an unreliable base for so large a nest (although one nest in a larch was placed on entirely dead branches). The hawks are clearly selecting a zone in the lower crown among the strongest and largest of the branches. Even in oaks, which have strong branches at all heights, the nests are situated in the same zone. The rigidity of the trunk at this height must also confer some stability: if the nest were any higher, it would sway unacceptably in strong winds. We have only one record of a chick (half-grown) falling from a nest during a severe gale. In conifers, nests are typically tucked in, tight against the trunk.

For a total of 36 nests in five tree species in the study area, the mean nest height was 17.6 m and the mean tree height 23 m; only eight nests (22%) were below 15 m (table 3).

Conservation

Most disturbance to nesting Goshawks in our study area is accidental, with forestry operations being the main cause. The hawks are using timber much larger than they do in other parts of Britain (Newton 1986)
and which is at the end of, or beyond, its commercial rotation. Nest trees are constantly at risk from felling and, although there is only one known instance of a felled tree landing against a nest, at least three pairs have failed when forest operations (up to 150 m away) kept adults off nests during incubation. At least two additional nests had part of their contents preyed on when the female was disturbed. Although there are instances of individual Goshawks nest-building while chain-saws were operating within 100 m, and of others sitting tight while felling was underway close by, these are exceptions. There were also individual females that slipped off the nest at the first indication of human presence. Most females, although sitting tight, when eventually flushed by forest work would not return until all activity in the area had ceased. Most workers would be unaware that they had flushed a Goshawk and were delaying her return, a situation disastrous in cold, wet weather. Flushing females at hatching time, when the chicks are only a few days old, can also be disastrous, with the chicks being carried out by a rapidly departing female.

All this aside, the Forestry Commission (the major landowner in the area) has, however, been very sympathetic when informed of potential
threats to nests. They have, whenever possible, timed their operations to cause the minimum of disturbance and have stopped work at respectable distances (300 m) or left nesting areas standing instead of clear felling.

Disturbance during the sensitive nest-building period can cause the hawks to move at short notice, possibly to less suitable areas. Also, clear felling during the non-breeding period (mid July to mid February) can completely remove the larger nesting trees from some territories, leaving inferior alternatives. Some pairs will, however, remain faithful to a particular stand, persisting to nest successfully in a greatly reduced area. In one instance, 9 ha of Douglas fir and oak were reduced when most of the fir was felled, and the pair remained in 1.25 ha of pure oak. In another instance, a 20-ha stand of Douglas fir was reduced to 5 ha, with the nest tree left in an isolated grove of 0.5 ha. Where felling must take place, it would perhaps be beneficial if scattered groves of 0.25-0.5 ha could be left through the forest. These isolated groves could, however, prove to be too vulnerable to discovery.

Secrecy has been paramount, and now, eight years after the first breeding discovery, only a handful of trusted people know of the Goshawk’s true status in the area. Records are deliberately suppressed, and Goshawks seen in breeding areas by birdwatchers have been referred to only vaguely in local bird reports. We believe that this secrecy has been a major factor in ensuring the safe expansion of the population, and it is for this reason that we decided to publish anonymously. A chance discovery by birders of one nesting site on the fringes of the study area became common knowledge, attracting others from up to 60 km away. That this pair is still successful can be attributed to the individual female’s tolerance, rather than to human discretion.

We are very fortunate that our study area is not subject to human persecution. Only two pairs are known to nest on keepered ground. At one site, a reported history of persecution has been countered by a direct approach to the landowner (owners are often unaware of the species’ presence) and involvement of the keeper in nest visits for research purposes. Once nest contents have been disclosed, it makes it difficult to explain (to us or the landowner) any subsequent persecution. Additionally, a relationship is struck up with the keeper, helping to break down old prejudices.

Nest robberies in the area are also few, this no doubt being associated

<table>
<thead>
<tr>
<th>Tree species</th>
<th>Sample</th>
<th>Mean nest height (m)</th>
<th>Range</th>
<th>Mean tree height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitka spruce Picea sitchensis</td>
<td>1</td>
<td>19.0</td>
<td>—</td>
<td>28.0</td>
</tr>
<tr>
<td>Douglas fir Pseudotsuga menziesii</td>
<td>8</td>
<td>19.1</td>
<td>16-29</td>
<td>24.6</td>
</tr>
<tr>
<td>Pine Pinus</td>
<td>3</td>
<td>16.0</td>
<td>15-18</td>
<td>21.3</td>
</tr>
<tr>
<td>Larch Larix</td>
<td>17</td>
<td>15.5</td>
<td>12-19</td>
<td>21.3</td>
</tr>
<tr>
<td>Oak Quercus</td>
<td>5</td>
<td>20.8</td>
<td>13-25</td>
<td>24.6</td>
</tr>
<tr>
<td>Beech Fagus sylvatica</td>
<td>2</td>
<td>23.5</td>
<td>18-29</td>
<td>26.5</td>
</tr>
</tbody>
</table>
with the size of the nesting trees. Nests are often at a height of over 18 m (table 3), and are placed in trees with wide straight trunks, often 12 m or more to the first dead branches. A climber almost has to reach the nest before he would consider himself safe. Nests prove inaccessible to all but experienced tree-climbers, and in two instances others have attempted, but failed, to reach nests. If these large stands were removed and the birds moved into smaller, more accessible timber, we should no doubt experience a higher incidence of robbery.

Summary of conservation guidelines

1. No forestry operations should take place within 300 m of nesting sites (to avoid flushing females) between early March and the end of May.
2. Blocks of large timber covering 0.25-0.5 ha should be left scattered through the forest.
3. Where nests are at risk on keepered ground, landowner/agent should be involved and kept informed of progress and possible disturbance threats.
4. Nesting sites should be kept confidential, and if necessary vulnerable sites protected, until the population has built up (five years).
5. Consideration should be given to felling nesting stands which are widely known about if other suitable nesting timber is available nearby.
6. If possible, clear felling in predominantly broadleaved areas and extensive clear felling in coniferous areas should be avoided.
7. Nest visits should be kept to a minimum at hatching time (May) to avoid very young chicks being carried out by a rapidly departing female.

Acknowledgments

We are grateful to the Forestry Commission and to various landowners and their agents for permission to enter their land, and to Dr C. J. Bibby, Dr I. Newton and local officers of the RSPB for constructive criticism and advice on an earlier draft. Unfortunately, some must, like ourselves, remain anonymous in order to protect the confidentiality of the study area. We wish to thank A. Roberts for his patience in typing and correcting the manuscript.

Summary

Between 1979 and 1986, a population of Goshawks Accipiter gentilis built up from one to at least 15 pairs. The highest density found was four pairs within 20 km² of woodland, with some nests only 1 km apart. In only a minority of cases was a nest used for two successive years. Larch Larix was the most favoured tree for nesting and for nest construction. Nests were large, flat structures, built in plantations near the end of their commercial rotation. They were built in the largest trees, typically three-quarters of the way up, at a mean height of 17.6 m. Guidelines are given to assist conservation work.

References